Driving your future.

Rail

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X CERTIFIED QUALITY
So you can be sure of one thing in future: your continued success.

MTU supplies its customers with technologically-advanced products that are proven in the field. MTU’s range of products and services for off-highway applications is extensive and includes both standard and customized solutions.

MTU is the core brand of Rolls-Royce Power Systems AG, which is a world-leading provider of high- and medium-speed diesel and gas engines, complete drive systems and distributed energy systems for the most demanding requirements.

The product range of MTU is one of the widest and most modern in the sector. We offer comprehensive, powerful and reliable engine solutions for yachts, commercial ships and naval vessels, construction and industrial vehicles, agricultural machinery, mining, rail and military vehicles as well as for the oil and gas industry. We also provide a full line of service products to help you maximize uptime and performance.

For over 100 years, MTU has been known for cutting-edge innovation and technological leadership. That same spirit of innovation inspires our sustainability efforts. Today and in the future, our focus is on developing and implementing system solutions to maximize efficiency and meet emissions standards.

An expert technological leader
MTU has always set standards in technological expertise for customized product and system solutions. To deliver you maximum power density, we concentrate our innovation on the continuous advancement of our core competences: turbo charging, exhaust aftertreatment and electronics.

A passionate engine specialist
We spend every day working together with you, our customers, to deliver engines and systems that best fit your needs. Whether a standard system or a customized solution – we are passionate about the art of engine creation.

A reliable partner
We understand the specific demands for diverse applications. In collaboration with you, we look for the solutions which are best suited to your individual requirements. Every step of the way – from the start of project planning, during the design of your integrated system solution, at the point of delivery and commissioning and continuing through the care of your product – we are there with you for the entire life-cycle.
Over the course of their lifetime, trains cover immeasurable distances, carry people and goods, bring support and ensure mobility. They move us and we move them. Our engines and drive systems make rail transportation powerful, reliable and safe.

Back in 1924, standard engines developed and manufactured by MTU were already being used in rail transportation and since 1950, we have supplied up to 20,000 engines as drive units and power generation units for railcars all over the world. Time and time again, over hundreds of millions of kilometers of rail, they have proven their absolute reliability, high operational availability and exceptional economic efficiency. They also incorporate the very latest in environmental technology and have the potential to meet future requirements.

These many years of experience, coupled with a unique level of expertise accumulated over decades, form the basis of our innovative strength and acknowledged systems capabilities. Locomotive and railcar manufacturers all over the world rely on us as their industrial partner.

With MTU ValueCare we offer a comprehensive portfolio of service products that ensure the optimum running and value retention of our drive systems over the long term. Our service network is at your disposal all over the world: always and everywhere.

1 State of the art
MTU rail engines are reliable, powerful and eco-friendly drive units found in many of today’s high-speed trains and many other rail vehicles.

2 Looking back
In 1933 our diesel engines powered the legendary “Flying Hamburger” to 160 km/h, a revolutionary speed at that time.
Increasing demand for local public transportation brings with it an ongoing need for modern railcars with the latest drive system technology. MTU - as the experienced specialist - provides the drive systems to support eco-friendly traffic designs.

The innovative MTU Rail PowerPacks® meet all the requirements of this high-performance sector, which demands far more than simply a “powerful engine”. Our extremely compact, complete systems are configured to suit individual customer needs and can then be integrated into the vehicle in a quick and easy process, using Plug&Play.

The high level of reliability of our drive systems ensures that trains can run on time and that operations keep running smoothly – a key factor in economic success. In addition, low operating costs and fuel consumption figures, long maintenance intervals and a maintenance-friendly design all help keep operating costs down and further improve efficiency.
Multiple-Unit trains require top-level performance over a long period, maximum operational availability and uncompromising economic efficiency. For this reason manufacturers and rail operators have depended on MTU’s Series 4000 rail drive systems for many years.

For high-speed trains in particular, which are playing an increasingly major role on national and international routes, the advantages of MTU engines come into their own. Extremely powerful and proven in continuous service, our drive systems demonstrate an excellent power-to-weight ratio and outstanding operational availability, enabling them to deliver the reliability, punctuality and safety expected from these high-tech trains.

A worldwide service network and on-site facilities at railway depots ensure optimum levels of support and minimum downtime.
MTU drive systems for mainline and multipurpose locomotives operate in a wide variety of conditions and are always custom-made to suit their specific areas of activity. They are in continuous use, day after day, and prove their reliability on every continent and over thousands of kilometers. They prove their worth in heavy goods operations just as much as at high speeds on long-haul passenger routes.

Long maintenance intervals, maintenance-friendly design and low specific consumption figures all contribute to keeping overall life-cycle-costs low and are thus important factors in the economically efficient running of rail vehicles.

MTU’s worldwide service network and local railroad depots give rail operators the highest possible level of confidence: fast and competent support minimizes unproductive downtime and ensures uninterrupted operational availability of rolling stock.
Shunting and industrial locomotives are true workhorses. Their specialized area of operation involves frequent load changes in all part-load operations and long periods spent in low-load operations. This gives rise to very specific demands on the drive system, which MTU engines meet with ease thanks to their excellent part-load performance and acceleration characteristics.

Our robust and powerful engines prove their reliability – one of the key factors in all rail applications – thousands of times every day. And since the smooth running of overall railroad operations depends to a considerable extent on the reliable functioning of shunting and industrial locomotives, our drive systems clearly have an important economic role to play. Long maintenance intervals and low specific fuel consumption figures are further arguments that convince operators of the efficiency of our engines.

And wherever your fleet may be: we are not far away. Our worldwide service network will ensure that rolling stock powered by our engines is always ready to go – and to operate – under even the toughest of conditions.
To keep railroad operations running smoothly at all times, a range of special rail vehicles provides supporting services. For these special-purpose vehicles, we provide custom-made drive solutions.

Low exhaust emissions make MTU drive systems ideal for use in a range of special-purpose vehicles such as tunnel servicing and maintenance locomotives used for construction or repair work in places like subway systems. A choice of diesel-electric, diesel-mechanical and diesel-hydraulic drive versions is available. We also offer diesel-hydrostatic drive systems for construction work and other special vehicles that operate at extremely low speed. Whichever you choose, all our engines come with the uncompromising levels of reliability, availability and economic-effectiveness you need.

As an industrial specialist, we offer the complete engineering package for every drive solution, from the project concept phase through to installation. Throughout the entire operating life of our engines, our service network and local rail depots will provide professional support: anytime, anywhere.
For over 90 years now, MTU rail engines and MTU PowerPacks® have been setting the standards by which diesel engines are measured in this demanding application. Their uncompromisingly low downtime helps keep rail operations right on schedule, and their high efficiency plays a key part in keeping them profitable. The very latest MTU emissions technology also makes our rail engines the cleanest power delivery systems in the world. Even so, we continue to press ahead and are developing innovative solutions that conserve natural resources and meet upcoming emissions regulations. In this way, we remain true to our social responsibility as an engine manufacturer – and as a partner helping secure your success as we move forward.
We develop the system to deliver your success.

A conventional drive system made up of individual components or an MTU PowerPack®: As an experienced system supplier we design and deliver individualized complete solutions, tailor-made to suit a specific application, a broad range of needs, and all associated conditions and requirements.

At the heart of what we do is always the engine. A choice of underfloor or engine room installation, low weight and compact installation dimensions make MTU diesel engines the best solution for drive systems in railroad vehicles.

The high flexibility of the system configuration makes the engines suitable for use in diesel-electric, diesel-mechanical or diesel-hydraulic drive units. This means that complete drive systems can be individually fitted.

A wide range of accessories is also available, to suit your requirements and all of these meet the same high quality standards as the engine itself. Such items ensure simple integration at all interface points as well as the functionality of required special features.

The high standard of our comprehensive engineering expertise is just as convincing. During the design phase of individual drive solutions, our Competence Center Rail, as we call it, will provide you with a level of expertise that is unique, anywhere in the world. On the basis of our long-standing experience and solid references, we can understand your requirements - no matter how difficult they may be. And no company except MTU has been able to consistently offer the complete package of capabilities that is necessary for the development of complete customer-specific solutions from one source.

Take advantage of our expertise.

1 MTU Power Packs® are installed in the vehicle as proven, all-in-one drive power systems. Each PowerPack is also available as a hybrid solution.

2 Conventional railroad drive systems Comprising a series of individual components. The foundation of each is our Series 4000 engines. In each case we design and supply an individual system solution.

### MTU PowerPack® and Engines

#### All engines at a glance.

<table>
<thead>
<tr>
<th>Engine Type</th>
<th>Page</th>
<th>kW</th>
<th>bhp</th>
</tr>
</thead>
<tbody>
<tr>
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<td>30</td>
<td>315-390 kW</td>
<td>422-923 bhp</td>
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<tr>
<td>MTU PowerPack 1600</td>
<td>32</td>
<td>565-700 kW</td>
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<tr>
<td>Series 4000</td>
<td>38</td>
<td>1000-3300 kW</td>
<td>1341-4425 bhp</td>
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</tbody>
</table>
Efficient and powerful:

MTU Power Packs® for railcars.

The MTU PowerPack® is an innovative drive system that combines all the individual system elements into a single functional unit mounted on a supporting frame. This system is specially designed for underfloor installation and is characterized by its particularly flat design. We supply all three types of power transfer: diesel-electric, diesel-mechanical and diesel-hydraulic. Every MTU PowerPack® can be individually configured.

**Features:**
- Responsibility for the design and performance of the drive system PowerPack as a whole stays in one place. A single supplier is responsible for all elements of the system – from the project initiation phase through to the final handover inspection.
- Interfaces are reduced to the most extreme system limits of the PowerPack®. This means that the complete system has been coordinated and tested by MTU well before it is installed in the vehicle.
- The Plug&Play configuration makes installation and removal of the unit quick and easy - also for maintenance purposes. Your trains are sure to run on time.
- The installation of a PowerPack® makes standardization possible and reduces complexity. This leads to better cost-effectiveness than through the use of individual components.
- The compact arrangement of the components reduces the total weight of the PowerPack®.
- An electronic control system monitors, controls and regulates all functions.
- For test purposes, it is possible to run the full drive system outside of the vehicle - even under load.
- The technology for eco-friendly drive systems: We take responsibility for technology – also in the interests of protecting the environment: Our PowerPack® meet all current legislative requirements, while we also already have the solutions to enable us to meet the next level of emissions standards. We meet EU Stage IIIA compliant and EU Stage V, with proven technologies, e.g. through an optimized combustion process and SCR technology. Selective Catalytic Reduction technology (SCR) involves the targeted aftertreatment of the exhaust gas to convert nitrogen oxides (NOx) to harmless, naturally occurring air components.
- Further features of the PowerPack® are their low particulate emissions and reduced levels of noise and vibration.

**The MTU PowerPack® offers:**
- Scope for individual configuration; flexible and standardized interface solutions
- Low operating costs
- High performance efficiency
- Lowest fuel consumption
- Minimal exhaust emissions
- Long service life and excellent reliability
- Simple maintenance
- High level of availability
- Minimal resource requirement thanks to Plug & Play

MTU PowerPack® – the highly compact, highly integrated solution.
- Frame
- Diesel engine
- Traction alternator
- Cooling system
- Exhaust system
- Auxiliary power supply

 Representation of a diesel-electric PowerPack®:

We have developed a series of individualized solutions covering a range of different frames and will use our extensive experience to find the appropriate solution to suit the requirements of any specific vehicle.

We offer a range of PowerPack® solutions with different power outputs and exhaust treatment technologies. These include diesel-electric PowerPack® solutions with and without Selective Catalytic Reduction (SCR) technology, as well as diesel-hydraulic and diesel-mechanical solutions.

We ensure that our PowerPack® solutions meet all current legislative requirements and are prepared to meet future emissions standards. Our solutions are designed for a range of applications, including underfloor and roof-mounted installations.

Our PowerPack® solutions are characterized by their low weight, compact design, and efficient operation. They are also designed for easy installation and maintenance, making them an ideal solution for a wide range of applications.

We take responsibility for the design and performance of the drive systems, ensuring that our solutions are of the highest quality and meet the needs of our customers.

We are committed to sustainability and ensure that our PowerPack® solutions are eco-friendly, with low emissions and reduced noise and vibration.

We work closely with our customers to provide custom solutions that meet their specific requirements, ensuring that our PowerPack® solutions are tailored to their needs.

Our PowerPack® solutions are designed to be reliable and durable, with a long service life and excellent availability. They are also designed for easy maintenance, ensuring minimal downtime for our customers.

We offer a range of PowerPack® packages, including standard and additional scope of supply options, allowing customers to choose the level of customization that best suits their needs.

Our team of experts is available to provide support throughout the design, installation, and maintenance phases of our PowerPack® solutions, ensuring that our customers receive the best possible service.

We are confident that our PowerPack® solutions will provide our customers with a reliable, sustainable, and cost-effective solution for their power needs.
Integration of the energy storage with roof installation:

1. Diesel engine
2. Electric motor/generator
3. Transmission
4. Exhaust aftertreatment (scr)
5. AdBlue® tank
6. MTU EnergyPack
7. System control

Savings fuel through braking energy recovery

With hybrid drives, braking energy is converted into electrical energy and stored in the battery. This energy can then be reused later as a boost on gradients or to accelerate. As a result, up to 25 percent of the diesel fuel can be saved. Hybrid technology is especially efficient for use on local lines where braking and acceleration in stop-go mode is frequent, and much of the braking energy can be recovered. In this case, the hybrid drive is amortised after just a few years.

Significantly reduced emissions through load point optimization

If during periods of low load factors the diesel engine is operated at a more favorable energetic operating point or switched off entirely, emissions can be reduced substantially: per kilometer, up to 230 grams less CO₂ and up to 0.92 grams less NOₓ compared with conventional systems.

Optimizing travel times with the Boost mode

With a combined diesel and electric drive, the train accelerates even better. When it comes to keeping tightly calculated schedules or catching up on delays, the electric motor provides additional torque. This means that the railcar can travel uphill faster or reach the target speed quicker. For example, the time for a 72-kilometer-long route can be shortened by more than five minutes.

Significant noise reduction

The electric motor can be used as the main drive when rail vehicles need to be operated as quietly as possible: For example, during travel through residential areas and tunnels or while stopped at a railway station. The noise level when stationary can be reduced by up to 21 decibels.

Flexible vehicle deployment and simple retrofitting

Naturally, rail vehicles with hybrid drive can also be powered exclusively by the diesel engine. This also means great flexibility for the operator: The trains can be deployed on both electrified and non-electrified rail routes. In addition, upgrading to a trimod* power system – with an additional pantograph – is easy because the system is already equipped with an electric motor. This gives the operator considerable freedom with regard to deployment of the vehicles – it’s a big plus when they can respond flexibly in the future to every route requirement or tender invitation.

* diesel + battery + catenary

Marketable technology – tailored solutions

Extensive test runs in a Siemens Desiro Classic Railcar (DB Series 642) have proven the reliability of the MTU Hybrid PowerPack®. The projections of the simulation have also been confirmed. As a result, MTU can make reliable statements to customers with regard to efficiency as well as the reduction of noise pollution and exhaust emissions, and offer them tailored hybrid solutions that in every case will generate the greatest possible benefits for the application.

The new generation of PowerPacks

The Hybrid PowerPack was developed from the successful MTU underfloor drives. Tried and tested MTU PowerPacks were modified and equipped with additional components and functionalities in order to integrate the hybrid technology. The MTU hybrid concept consists of a modular kit with a variety of drive elements. It satisfies all existing railway standards and can be arranged according to customer specifications.

Thanks to its compact design and the use of power-dense electrical machines, the Hybrid PowerPack can be easily integrated in the existing installation space under the floor, both in new rail vehicles and in repowering of an existing vehicle. MTU EnergyPacks – the energy storage – can be positioned at various places in the vehicle: in the roof or in the space under the floor of the railcar. The modular design creates great flexibility for operators who are planning new vehicles or want to convert existing vehicles.

Based on specifications for the vehicle and the profile of the planned routes, MTU can simulate the lifecycle costs (capital, maintenance and operating costs) of specific projects. This means that a variety of drive options can be defined even before the design stage. Together with the customer, we then determine an optimal needs-based concept.

MTU Hybrid PowerPack®

Make faster, cleaner progress.
With the MTU Hybrid PowerPack®.

Underfloor mounting
MTU PowerPacks® for Railcars, Underfloor and Roof Installation

Series 1800

The benefits to you:

- Constant design improvements with the same footprint (module strategy)
- Can operate with zero emissions on chosen stretches: with the Hybrid PowerPack
- Over 20 years of systems capability
- Ready to repower: extend the life of your investment

<table>
<thead>
<tr>
<th>Series 1800</th>
<th>DH 1800 R</th>
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<tbody>
<tr>
<td>Engine model</td>
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<tr>
<td>Cylinders</td>
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<td>Power output kW</td>
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<td>bhp</td>
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<td>Drive systems 1)</td>
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1) Drive systems:
DM = diesel-mechanical
DH = diesel-hydraulic
DE = diesel-electric

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<td>Type</td>
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</tr>
<tr>
<td>Energy Content kWh</td>
<td>30.6 61.2 91.8 122.4</td>
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</table>
MTU PowerPacks® for Railcars, Underfloor Installation

Series 1600

The benefits to you:

- Constant design improvements with the same footprint (module strategy)
- Can operate with zero emissions on chosen stretches:
  - with the Hybrid PowerPack
- Over 20 years of systems capability
- Ready to repower: extend the life of your investment

<table>
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<tr>
<th>Series Engine model</th>
<th>1600 12V 1600 R</th>
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¹ Drive systems:
- DM = diesel-mechanical
- DH = diesel-hydraulic
- DE = diesel-electric

Battery System

<table>
<thead>
<tr>
<th>MTU EnergyPack Type</th>
<th>151M1P</th>
<th>151M2P</th>
<th>151M3P</th>
<th>151M4P</th>
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<tbody>
<tr>
<td>Energy Content kWh</td>
<td>30.6</td>
<td>61.2</td>
<td>91.8</td>
<td>122.4</td>
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</tbody>
</table>
Set new Standards:

MTU engines for railcar trainsets and locomotives.
Series 4000 — on tracks all over the world.

Through Siberian ice deserts. Through sandstorms. In the blistering Australian Outback. Over extreme gradients. Throughout the world, Series 4000 diesel engines drive heavy trains through difficult terrain. In heavy freight train operation as well as at high speeds in passenger train service. Without tiring. The numbers speak for themselves: of the total of 37,000 Series 4000 engines sold since 1996, the rail application accounts for altogether more than 3,000 engines. These alone have already reliably completed 65 million hours of operation for 240 customers in over 70 countries.

For over 20 years, MTU Series 4000 engines have been the preferred drive systems for modern locomotives. Over hundreds of millions of kilometers, these engines have set the benchmark for what a high-performance rail drive system needs to deliver in this day and age. Absolute reliability. Maximum operational availability. Uncompromising economic efficiency.

Fewer emissions with less fuel consumption and improved overall economy at the same time — oriented to the very real requirements of the rail operation. The Series 4000 embodies our competences in all essential key technologies, reducing emissions and consumption. It manifests our claim of offering you the optimal system solution in each case. And it provides you – just as you would expect from MTU drive solutions – with much more than just sophisticated and constantly improved technology: all the prerequisites for more success in your application. Now and in the future.

The Series 4000 in overview:
— Cylinder variants 8V, 12V, 16V, 20V
— Lower emissions and consumption thanks to the common rail injection system
  - 20 years ago, as the first and only Off-Highway engine manufacturer, MTU introduced the common rail injection system.
  - Now in the fourth generation, the tried and tested and continuously further developed key technology ensures that MTU engines will continue to set the standards in economy and low emissions.
— Optimum charging due to MTU exhaust gas turbocharger
  - High charge pressures lead to increased power yield and reduced particulate emissions
  - High efficiency for low fuel consumption
— Optimized combustion process
  - Reduction of NOx due to Miller cycle at optimal fuel consumption
— ADEC electronics (engine control system)
  - Robust MTU electronics, perfectly matched to the engines

Advanced technology for environmental friendliness – the new generation: Series 4000 R04
The new Series 4000 engines with our emissions technology represent the next generation of an engine series that has been proven thousands of times over. They fulfil the current emissions legislation EU Stage IIIb as well as US EPA Tier 3 – and are thereby very compact, powerful and extremely economical.

Our innovative emissions technology meeting EU Stage IIIb is based on both in-engine and aftertreatment solutions.

In-engine technologies minimize the generation of pollutants during combustion:
— Cooled exhaust gas recirculation
— LEAD 2 injection system up to 2200 bar
— 2-stage regulated charging, 3 turbochargers, intercooling
— NOx-optimized valve control (Miller cycle)
— New low-NOx, low-soot combustion process
— Max. cylinder pressure 220+10 bar
— Advanced Diesel Engine Control system (ADEC) with emissions regulation

The aftertreatment technology eliminates over 90% of particulate emissions through use of a diesel particle filter with passive regeneration.

Further MTU key technologies for the reduction of emissions and consumption can be found in the Overview on page 72/73.

Through Siberian ice deserts. Through sandstorms. In the blistering Australian Outback. Over extreme gradients. Throughout the world, Series 4000 diesel engines drive heavy trains through difficult terrain. In heavy freight train operation as well as at high speeds in passenger train service. Without tiring. The numbers speak for themselves: of the total of 37,000 Series 4000 engines sold since 1996, the rail application accounts for altogether more than 3,000 engines. These alone have already reliably completed 65 million hours of operation for 240 customers in over 70 countries.
Engines for Push-Pull Trains, Shunting Multi-Purpose and Mainline Locomotives, Engine Room Installation

Series 4000

The benefits to you:

• Reliable performance – in all conditions
• Clean power – pure profitability
• The preferred drive power system for locomotives and push-pull trains for over 20 years now
• Ready to repower: extend the life of your investment

<table>
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<tr>
<th>Series</th>
<th>Engine model</th>
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<th>4000 R43</th>
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<td>EU Stage IIIA compliant/ UIC IIIA</td>
<td>EU Stage IIIA compliant/ UIC IIIA</td>
<td>EPA Tier 3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Repowering Solutions

New heart.
New life.
Our expertise as your industrial partner means that MTU will not only provide the engines to be repowered but will also deliver a comprehensive package of support services:

— Design phase through implementation of the drive system; active support and professional engineering through all stages of the repowering project.

— Supply of the very latest, extensively proven engines and Power Packs® with the compact dimensions that make them simple to mount in the available space, and with an excellent power-to-weight ratio that makes the installation of higher outputs possible without permissible axle loads being exceeded.

Following the conversion, the reduced operating costs bring the following potential savings for the operator:

— Reduction in fuel costs.

— Long maintenance intervals and minimal maintenance costs thanks to new maintenance concept.

— Legal requirements are met with well-proven combustion technology; low fuel and oil consumption lead to low pollutant emissions and thus high regard for the environment.

— Lower investment costs through reducing reserve locomotive stock.

— Limited downtime thanks to high availability and high reliability.

After reconditioning and repowering, tried and tested locomotives and railcars can be a genuinely economical alternative to placing a new order with four positive effects:

— The use of a modern MTU diesel engine reduces operating and maintenance costs, maximizing the economic benefits to the operator.

— All legally stipulated exhaust gas emission standards are met. Noise emissions are also significantly reduced.

— The availability and reliability of the vehicles are brought up to the level of a new vehicle.

— The cost of investment is considerably lower than if a new vehicle was purchased.

Our expertise as your industrial partner means that MTU will not only provide the engines to be repowered but will also deliver a comprehensive package of support services:

— Design phase through implementation of the drive system; active support and professional engineering through all stages of the repowering project.

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One step ahead of the future: with digitally networked, intelligent drive power systems.

If you want to achieve new goals, you have to break new ground. The development path leading to MTU’s automation systems shows clearly how today’s innovative drive can become tomorrow’s innovative drive solution: they have a modular design, are easy to integrate, and enable the customer to realize the very highest levels of efficiency and available performance. Like a digital brain, they control, regulate and monitor system functions. An an important integral part of our drive systems, and used in connection with our digital products, they deliver the ultimate in efficiency, reliability and environmental compatibility, not to mention all the benefits of simplified vehicle and fleet management.
### Automation and Peripheral Systems

#### All products and benefits at a glance.

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<tr>
<td>Scope of supply</td>
<td>- PowerPack Automation</td>
<td>- SIL (Safety Integrity Level) certified monitoring unit</td>
<td>- ADEC Governor</td>
<td>- Ultracap</td>
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<td>- Safety- and approval-related documentation</td>
<td>- PAU Engine (Power Automation Unit)</td>
<td>- DC/DC voltage transformer</td>
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<td>- PAU Traction</td>
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<td>- POM (Power Output Module)</td>
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<tr>
<td>Advantages at glance</td>
<td>- Automation for complete system</td>
<td>- Monitors safety-relevant functions and ensures safe operation</td>
<td>- Special rail automation system</td>
<td>- Electrical system voltage 16V DC – 154V DC</td>
<td>- Ultracap</td>
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<tr>
<td></td>
<td>- Powerful and scalable</td>
<td>- Documentation simplifies the approval process</td>
<td>- Central interface for complete system</td>
<td>- CAN interface</td>
<td>- Integral charger</td>
</tr>
<tr>
<td></td>
<td>- For new rolling stock and repowering projects</td>
<td></td>
<td>- For new-production and repowering projects</td>
<td>- Maintenance-free</td>
<td>- Stand alone component</td>
</tr>
<tr>
<td></td>
<td>- An intelligent system for the entire PowerPack line-up</td>
<td></td>
<td>- Certified for rail applications</td>
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<td>- Enclosure rating IP66</td>
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#### MTU Power Packs® for Railcars

<table>
<thead>
<tr>
<th>Series</th>
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<tr>
<td>1800</td>
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<td>1600</td>
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#### MTU Engines for Railcar Trainsets, Push-Pull Trains and Locomotives

<table>
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<tr>
<th>Series</th>
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<td>4000</td>
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*only available for 8V 4000 engines*
MTU PowerControl Automation

Like a digital nervous system that doesn't miss a thing.

Visionary, and packed full of benefits: The MTU PowerControl Automation system is MTU’s innovative high-end technology for rolling stock, i.e. railcars. MTU PowerControl Automation optimises the control, regulation and monitoring of the entire drive system. The modular system ensures that the drive system can be adapted to the complex operating conditions that occur in railway applications.

MTU PowerControl Automation enables:

• Simple integration with new or – in the case of conversions – existing vehicle control systems
• Flexible adjustment capability to suit the vehicle, its components and project-specific requirements
• Automatic power adjustment or, if required, engine shutdown by the integrated safety system as well as all other required monitoring and safety functions
• The built-in automatic power management system ensures that maximum available drive power is always to hand
• Maximum uptime in the tough operating conditions that confront rail operators, including extremes of heat, cold, airborne dust and water spray

The new MTU PowerPack® generation therefore offers you:

• High power efficiency
• Minimum fuel consumption
• Minimum exhaust emissions that are significantly below statutory requirements (e.g. valid EU Stage IIIA and EU Stage IIIIB)
• Flexible, standardized interface solutions

An optimum environment for diagnosis and maintenance:

• Provision of operating and diagnostic data for maximum drive system uptime
• Unlocking the full potential of MTU systems using MTU's digital solutions MTU Go! Act and MTU Go! Manage, for example via
  • proactive failure prevention
  • fast service support through efficient communication tools
  • intelligent troubleshooting
  • optimized maintenance planning

MTU PowerControl Automation in the PowerPack

Exhaust Gas Aftertreatment

Engine sensors and control elements

PowerPack® system components

Gearbox control system

Axle reversing transmission control

MTU PowerControl Automation across the entire vehicle group

Connectivity for digital solutions (Go! Act, Go! Manage)

System highlights and benefits:

• Complete system supplied from one single source
• Modular design
• Optimized diagnostic function
• Intelligent CAN bus technology
• Fast project implementation
• Easy integration

Urea dosing unit; Heating valve and urea nozzle

SCR muffler with catalyst

Urea tank

ADEC governor

Engine mounted

PowerPack mounted

Vehicle mounted

MTU PowerControl Automation

MTU PowerControl Automation is a modern interface module with a leading edge design and high connectivity.

Available interfaces to the vehicle control system:

– CAN-Bus interface with CANopen or SAE J1939 protocols
– 10BASE-T / 100BASE-TX Ethernet
– 24V DC binary inputs and outputs
– 0-5V DC / 0-10V DC / 4-20mA analog inputs and outputs
SafeMon for Power Packs®: the integrated safety center

All-round protection.

For vehicle manufacturers and railway operators, the safety of their passengers has top priority. With the MTU SafeMon (Safety Monitor) we help you to reduce operational risks – and to achieve the set safety objectives even faster and easier.

SafeMon consists of a certified monitoring unit for safety-relevant functions as well as the associated safety- and approval-related documentation. The functions that control these signals fulfill the level of safety specified by the operator, rated according to Safety Integrity Level (SIL). This specifies that in the event of faulty or defective components, safety-relevant procedures, such as braking, coupling or uncoupling, are guaranteed just as before. As a result, consequential damage due to unwanted traction or overspeed is prevented.

MTU develops the safety technology in-house - and it is therefore perfectly oriented to the MTU PowerPack. SafeMon is integrated directly in the power system via a simple hardware interface; existing vehicles can also be readily upgraded. Manufacturers of rail vehicles receive a complete package that has already been subjected to all hazard- and risk assessments and certified for the safety level that they require; MTU prepares the corresponding documentation.

The separate safety certificate can be included directly in the report for the independent assessment body. This considerably simplifies the approval process for the complete vehicle.

With SafeMon you are safely en route at all times:
- Complete safety concept for the entire power train
- Control of all safety functions according to the required safety level
- Completely documented and already examined by external bodies
- Complete power system from a single source, certified according to the European Standard for Proof of Safety (EN 50129)
- MTU supplies the associated documentation and thereby simplifies the approval process

The Safety Integrity Levels have been determined in accordance with the CSM Regulation (Common Safety Methods) and confirmed by independent experts.
Everything under control.

The most important features at a glance:
- Component mounted on and wired into the engine
- Integrated control and monitoring system
- Fuel-optimized output regulation
- Integrated safety and self-test system
- Data bus interface

PAU Traction (Power Automation Unit)
Module for the monitoring, control, regulation and system integration of the traction generator and rectifier, with the following features:
- For drive systems with direct-current series-wound engines
- Optimized output regulation, configured for the diesel engine
- Generator, rectifier and vehicle engine monitoring
- Field weakening control for vehicle engine
- Wheel-slip protection
- Integrated safety functions [e.g. power shut-off]
- Ethernet interface [e.g. service laptop]
- Internal fault ring buffer
- Locomotive safety functions
- Specification includes current and voltage transformers plus amplifier for generator excitation

Peripheral engine components
- Fuel pump
- Cooling fan
- Coolant level switch

MTU powerline PAU Traction for repowering of diesel-electric locomotives
CaPoS – Capacitor Power System for Series 4000

Innovation right from the start.

CaPoS is an innovative UltraCap voltage supply system which obviates the need for conventional starter batteries in railroad applications.

CaPoS uses capacitor technology to optimize startup behavior. The number of UltraCap modules used is dependent on the motor type/power system and its breakaway torque. CaPoS may be used autonomously or in conjunction with the powerline automation system.

The most important features at a glance:

- Autonomous and modular construction
- Maintenance-free system
- Significant reductions in weight and volume compared with conventional starter batteries
- Optimized cold-starting properties
- Low life-cycle-costs
- No voltage dip in the onboard network during the start procedure
- Onboard voltage of 16V - 154V possible
- Wired-up complete system
- CAN interface with powerline
CaPoS smart edition – Capacitor Power System for Series 1600, 1800 and 4000

Reliable power right from the start.

CaPoS smart edition was especially developed for heavy and duty applications and provides the high energy required by the 24V DC starters during the starting sequence.

CaPoS smart edition uses capacitor technology to optimize start-up behavior. The number of modules used is dependent on the motor type/power system and its breakaway torque.

The most important features at a glance:
- Autonomous and modular construction
- Maintenance-free system
- Significant reductions in weight and volume compared with conventional starter batteries
- Optimized cold-starting capabilities
- Low life-cycle-costs
- No voltage dip in the onboard network during the start procedure
- Onboard voltage of 24V DC
- Integrated self-monitoring system with interface to vehicle control system
- Integrated DC-/DC converter for automatical recharging
- IP66 protection

<table>
<thead>
<tr>
<th>Module 1</th>
<th>Module 5</th>
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<tbody>
<tr>
<td>According to motor type/power system, use of 1 to 5 UltraCap modules</td>
<td></td>
</tr>
</tbody>
</table>

1) for Series 1800
2) for Series 1600, Series 1800
3) for Series 1600, Series 4000
* Optional for Series 1600
How complete lifecycle solutions help

Ensure a long, reliable life.

As your equipment ages, its needs—and yours—change. MTU ValueCare wraps around your MTU investment, providing 360 degrees of customized support, for optimal value at every stage of life.

1. Avoid the unexpected with added protection beyond the standard warranty.
2. Make better decisions faster with digitally-enhanced tools.
3. Maximize availability and optimize lifecycle costs with a ValueCare Agreement.
4. Improve system performance and extend equipment life with on-demand support from MTU.
5. Keep a good thing going with MTU reman/rebuild solutions.
Why preventive maintenance is essential

Don’t let the unknown leave you unprepared.

With large investments, lifecycle costs can be significant. It’s often the unforeseen costs lurking below the surface—things like fuel consumption, unplanned downtime and repairs—that have the greatest potential to impact your business. That’s why it pays to invest in a superior MTU power system and plan ahead with preventive maintenance. There’s no better way to optimize fuel economy, maximize uptime and avoid the unexpected.

Optimize fuel economy.
Fuel consumption accounts for up to 90 percent of total lifecycle costs depending on the application—by far one of the most significant costs associated with your equipment. Well-maintained MTU engines deliver industry-leading fuel efficiency, helping you keep fuel costs down over the long term.

Maximize uptime.
Preventive maintenance services can be planned around your schedule, so your equipment is available when you need it most.

Avoid the unexpected.
Planned maintenance helps solve problems before they start, helping you avoid unexpected downtime and resolve problems early before they escalate.

Work with one source.
MTU keeps maintenance simple, safe and efficient. Our factory-approved methods and expert technicians ensure everything is done correctly according to proprietary MTU preventive maintenance schedules, optimizing the availability of your equipment, reducing lifecycle costs and helping you avoid unforeseen problems.

The Importance of Preventive Maintenance

When preventive maintenance is a high priority. When preventive maintenance is a low priority.

More Preventive Maintenance

Less Preventive Maintenance

More Corrective Maintenance

Less Corrective Maintenance

1. Scheduled stops
2. Improved performance
3. Better control over operation

1. Nonscheduled stops
2. Inability to plan
3. Lower performance

MTU focuses on preventive maintenance to reduce the downtime and added costs of corrective maintenance.

Delaying maintenance increases unexpected failures and decreases performance and fuel economy.
MTU-certified technicians

Rely on MTU expertise.

To give your equipment a long and productive life, choose a partner you can trust. Only MTU-certified technicians know how to get the job done right using proven service methods, MTU-specified maintenance schedules and genuine OEM parts.

From preventive maintenance to complete rebuild, MTU is your true lifecycle partner. Whatever level of support you need, our global network of factory-trained professionals knows all about your equipment and is ready to prepare a customized plan to help you maximize performance and minimize lifecycle costs.

Never compromise. MTU engines and systems are built to last with legendary high standards. When it’s time for service, don’t settle for anything less. Protect the life of your equipment with professional MTU-certified service technicians and genuine OEM parts and consumables—the only options that live up to MTU standards for craftsmanship, quality and performance. To get the most from your equipment, there are no shortcuts. For maximum reliability, performance and uptime, choose a name you can trust—MTU.

If you need us a little:
On-Demand Support—including professional inspections and preventive maintenance recommendations from MTU—helps you identify and address problems early, save on repairs or unexpected downtime, and optimize your equipment’s performance and longevity. Inspections include visual assessment, test run and leak check, on-site oil and coolant analysis, diagnostic evaluation and reporting.

If you need us a lot:
ValueCare Agreements make it easy to keep your business running smoothly and reduce total cost of ownership by maximizing uptime, optimizing lifecycle costs and helping you avoid equipment-related business disruptions through preventive maintenance.

Focus on your operations. Leave the rest to us.

You’ve got a tough job. With MTU you get the power, performance and peace of mind to get it done right. Our digitally connected power systems, wrapped in ValueCare Agreements, make it easy to keep your business running smoothly and reduce total cost of ownership by maximizing uptime, optimizing lifecycle costs and helping you avoid equipment-related business disruptions through preventive maintenance.

ValueCare Agreements help you:

- Increase operational uptime
- Guarantee parts availability and service quality
- Predict equipment-related costs
- Optimize maintenance planning
- Connect to MTU, 24/7

ValueCare Agreements make it easy to optimize lifecycle costs, maximize uptime and devote more time and resources to your core business, with tailored solutions to move your business forward.

Bronze

- Ensure parts availability and price stability
  - Only for customers with self-service maintenance capabilities
  - Predefined rate per operating hour for basic maintenance components
  - Automatic delivery of preventive spare parts based on operating hours
  - Quarterly maintenance reporting and maintenance forecast
  - Annual on-site engine health check

Silver

- Eliminate unexpected maintenance costs
  - Predefined rate per operating hour for maintenance and repairs
  - Predefined prices for extended component maintenance and major overhauls
  - Quarterly reliability reporting
  - Proactive remote engine health monitoring, including maintenance planning and troubleshooting

Gold

- Maximize operational uptime
  - Operational uptime commitment to meet or exceed your availability targets
  - Engine preservation management
  - Monthly reporting including availability and repair times
  - Annual performance meetings and trend analysis

Silver also includes all benefits of Bronze level

Gold also includes all benefits of Silver level

Gold also includes all benefits of Silver level

Silver also includes all benefits of Bronze level

Service solutions designed around your priorities.

ValueCare Agreements make it easy to optimize lifecycle costs, maximize uptime and devote more time and resources to your core business, with tailored solutions to move your business forward.

«Delivering a best-in-class travel experience requires an uncompromising commitment to quality. And that’s exactly what we get from MTU—reliable power systems with complete lifecycle support.»

Andy Clarke
Head of Commercial (Engineering), Great Western Railway
Remanufactured Products

Exchange and save.

Factory remanufactured MTU products deliver the same high standards of performance, service life and quality as new MTU products, along with identical warranty coverage—at a fraction of the cost. And with design and model-related updates, they also feature similar technological advancements. Developed by R&D engineers, the remanufacturing process saves you time and money, while benefiting the environment through the reuse of materials. To help you work efficiently, a wide range of remanufactured parts, engines and systems are available worldwide.

Reduce lifecycle costs. As you evaluate your long-term power needs, you must consider a variety of factors. Factory remanufactured products are a smart solution, helping you reduce the total lifecycle cost of your equipment.

Save time. Factory remanufactured products put your equipment back to work faster than an overhaul, which reduces downtime, service time and indirect costs such as storage.

Maintain MTU standards. All products are remanufactured to strict MTU standards by MTU-certified technicians at regional MTU reman centers. Only MTU can remanufacture MTU parts, engines or systems to original MTU factory specifications.

Protect the environment. Since remanufacturing is an efficient use of resources and energy, factory remanufactured products benefit the environment as well.

---

The future is digital.

For over 100 years, we’ve been known for technological innovation and leadership—driving efficiency and reliability to new heights. Today, we’re applying that same spirit of innovation to digitalization. Fueled by your system’s data—and supplemented with MTU’s exclusive expertise, smart analytics and extensive database—our digital solutions magnify the power of your MTU investment.

For proactive failure prevention and intelligent troubleshooting to instant failure support and smart maintenance planning, digital solutions unlock the full potential of your MTU system.

From proactive failure prevention and intelligent troubleshooting to instant failure support and smart maintenance planning, digital solutions unlock the full potential of your MTU system.

---

Digital Solutions

The future is digital.

Go! Act

1. Service in your pocket
   Designed to support on-site operators of MTU-powered equipment, Go! Act:
   - Receives push notification of failure codes from connected assets
   - Provides crew members with vital information about failure codes
   - Supports event reporting with convenient photo capture functionality
   - Enables direct communication with fleet managers or the MTU Customer Assistance Center

2. Monitor your fleet
   Built for fleet managers with MTU-powered equipment, Go! Manage:
   - Provides a live overview of fleet, asset and engine conditions
   - Displays active and closed alarms
   - Enables interaction and communication with on-site staff via Go! Act
   - Shows maintenance schedule, with completed tasks clearly marked
   - Supports remote troubleshooting via multigraph

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Go! Manage

1. Service in your pocket
2. Monitor your fleet

---

Exchange Process
Whenever and wherever you need expert support, MTU specialists are available. Our global service network of more than 1,200 locations – backed by our cutting-edge Parts Logistics Centers – provides you this assurance. To find your local MTU distributor, visit [www.mtu-online.com](http://www.mtu-online.com).

Local support. Worldwide.

Whether it’s connecting you with a local service partner or assigning an urgent problem to a dedicated team of MTU experts, we’re ready to assist you— wherever you are, whatever you need.

Europe, Middle East, Africa +49 7541 90-77777
Asia/Pacific +65 6860 9669
North and Latin America +1 248 560 8888

info@mtu-online.com
Overview of MTU engines

Series and emissions qualification.

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<thead>
<tr>
<th>Engine model</th>
<th>UIC IIIA</th>
<th>EU Stage IIIA compliant</th>
<th>EU Stage IIIB certified</th>
<th>US EPA Tier 3</th>
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<td>MTU PowerPacks® for Railcars</td>
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</tr>
<tr>
<td>1 Series 1800</td>
<td></td>
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<tr>
<td>2 Series 1600</td>
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<tr>
<td>MTU Engines for Railcar Trainsets, Push-Pull Trains and Locomotives</td>
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<tr>
<td>3 Series 4000</td>
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<tr>
<td>8V/12V/16V/20V 4000 R43</td>
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<tr>
<td>20V 4000 R63</td>
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<tr>
<td>12V/16V 4000 R54</td>
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<tr>
<td>12V/16V 4000 R54/74/84</td>
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</table>

1) EU IIIA type approved. Under special preconditions certification available on request.
Key technologies for the reduction of emission and consumption.

<table>
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<tr>
<th>Engine model</th>
<th>Exhaust Gas Aftertreatment</th>
<th>Internal Emission Technology</th>
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<td>Railcar Series 1800</td>
<td>SCR</td>
<td>4 EGR</td>
</tr>
<tr>
<td>Railcar Series 1600</td>
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<td>5 Two-Stage Turbocharging</td>
</tr>
<tr>
<td>Locomotive Series 4000</td>
<td></td>
<td>6 Enhanced common rail injection</td>
</tr>
</tbody>
</table>

**Exhaust Gas Aftertreatment**

1. Selective Catalytic Reduction (SCR)
   - The SCR system can remove as much as 90 percent of nitrates from exhaust gas. In SCR development, MTU has primarily focused on low fuel consumption and a low space requirement for SCR components.

2. Diesel Particulate Filter (DPF)/Diesel Oxidation Catalyst (DOC)
   - MTU Diesel Particulate Filters and Diesel Oxidation Catalysts are capable of lowering soot emissions to levels that in some cases are well below the statutory limits. Statutory limits form part of the emissions concept.

**Internal Emission Technology**

4. Exhaust Gas Recirculation (EGR)
   - Exhaust Gas Recirculation can reduce nitrogen oxide generation within the cylinder by 43 percent and more. MTU has designed a solution for compact integration of all EGR components so that virtually no additional space is required. This enables customers to upgrade their rail vehicles for compliance with the new emissions standards at no great expenditure.

5. Two-Stage Turbocharging
   - Turbocharging enables MTU engines to achieve low fuel consumption and high power output across a wide speed range. Turbochargers are finely adjusted to suit the demands on the engine in terms of cost-effectiveness, performance, dynamic response, and service life. Space-saving integration of turbochargers into the engine brings the customer the added benefits of compact design.

6. Enhanced common rail injection
   - MTU has been using common rail systems successfully for over 20 years now. Our MTU systems capability means we’re able to exploit potential during the combustion process to help make engines especially clean and economical.
MTU quality is something you can measure – and feel.

We have set the standard by successfully retaining our ISO 9001 certification for many years now, and have so proven time and time over how our capabilities can benefit our customers. Yet what we have already achieved is not enough for us - it is just a basis and gives us the momentum for our further development and continuous improvement.

Other credentials - UIC-certification of Series 4000 engines, the environmental management certificate ISO 14001, and "Q1 supplier" classification by Deutsche Bahn – speak for themselves and for the high level of quality and customer satisfaction that MTU offers.